RAYTHEON

TECHNICAL INFORMATION SERVICE

Technical Information

12AT7WA

RELIABLE MINIATURE DOUBLE TRIODE

The 12AT7WA is a heater–cathode type, high–mu double triode of miniature construction, suitable for use in amplifier, mixer, oscillator, multivibrator and computer circuits. The high amplification factor (60) makes it ideal for audio amplifier service where a gain of 40 is easily realized. The low plate resistance plus the ample peak plate current make this type ideal for pulse amplifier and low power servo amplifier service. This type is controlled for cathode interface and is designed for dependable operation under conditions of shock and vibration encountered in mobile, aircraft and missile applications. A heater center tap is provided to permit operation at 12.6 volts or parallel operation at 6.3 volts.

MECHANICAL RATINGS:

Maximum Impact Acceleration (Shock–Test–Note 3)	630	G
Maximum Vibrational Acceleration (96 hour Fatigue Test–Note 4)	2.5	G
Maximum Bulb Temperature	165	°C
Altitude	60,000	ft.

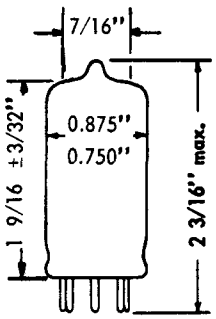
ELECTRICAL DATA

Ratings and Normal Operation	MIL–E–1 Symbol		Test Limit or Design Minimum	Normal Test Conditions	Normal Operation	Test Limit or Design Maximum	MIL–E–1 Units
				Ratings			
Heater Voltage	Ef:	Series	11.4	12.6	12.6	13.9	V
		parallel	5.7	6.3	6.3	6.9	V
Plate Voltage	Eb:		---	250	250	330	Vdc
Grid Voltage	Ec1:		–55	0	0	0	Vdc
Plate Dissipation (per Plate)	Pp/p:		---	---	2.5	2.5	W
Heater–Cathode Voltage	Ehk:		---	---	---	±100	v
Grid Resistance — Fixed Bias	Rg/g:		---	---	---	0.25	Meg.
Grid Resistance — Cathode Bias	Rg/g:		---	---	---	0.5	Meg.
				Tests			
Plate Current (1) (per plate)	Ib/p:		7	---	10	14	mAdc
Cathode Resistance (per cathode)	Rk/k:		---	200	200	---	ohms
Transconductance per plate	Sm/p:		4500	---	5500	6500	μmhos
Amplification Factor	Mu/p:		50	---	60	70	---
Heater Current (Series)	If:		142	---	150	158	mA
Plate Current (2) Cut–off (Ec1 = –20 Vdc)	Ib/b:		---	---	---	100	μAdc
Plate Current (1) difference between sections	ΔIb:		---	---	---	3.2	mAdc

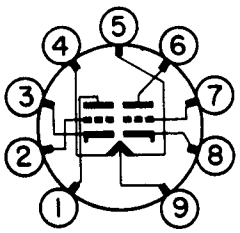
MECHANICAL DATA

ENVELOPE ..... T6½ Glass
OUTLINE ..... JEDEC (6–2)
BASE ..... 9 Pin Miniature
BASING 9A
MOUNTING POSITION ..... Any

PHYSICAL DIMENSIONS



BASING



BOTTOM VIEW

TERMINAL CONNECTIONS:

Pin 1 Plate, Unit #2
Pin 2 Grid, Unit #2
Pin 3 Cathode, Unit #2
Pin 4 Heater
Pin 5 Heater
Pin 6 Plate, Unit #1
Pin 7 Grid, Unit #1
Pin 8 Cathode, Unit #1
Pin 9 Heater Center–Tap

Ratings and Normal Operation	MIL-E-1 Symbol	Test Limit or Design Minimum	Normal Test Conditions	Normal Operation	Test Limit or Design Maximum	MIL-E-1 Units
			Tests			
Vibration (parallel) f=40 cps; G=10	Ep:	---	---	---	100	mVac
Capacitance (no shield)	Cgp:	1.3	---	1.6	1.9	μμf
Capacitance (no shield)	Cin:	2.0	---	2.5	3.0	μμf
Capacitance (no shield) Section 1	Cout:	0.20	---	0.45	0.70	μμf
Capacitance (no shield) Section 2	Cout:	0.16	---	0.38	0.60	μμf
Capacitance (no shield)	Cpp:	0.15	---	0.24	0.33	μμf
Capacitance (no shield)	Chk:	2.1	---	2.8	3.50	μμf

SPECIAL TESTS AND RATINGS TO INSURE RELIABILITY.

Randomly selected statistical samples are subjected to the following tests:

Shock Test – 630G. 42° hammer angle in Navy high impact shock machine. Sample subjected to twenty impact accelerations, five impact accelerations in each of four different positions.

Fatigue Test – 2.5G. Sample subjected to vibrational acceleration of 2.5G for 96 hours (32 hours in each of three positions). The sinusoidal vibration is applied at a fixed frequency between 25 and 60 cycles per second.

Glass Strain – A sample is subjected to a forty eight hour holding period at room temperature. The sample is immersed in water at 97–100 °C for 15 seconds and immediately immersed in water at not more than 5 °C. The sample is then dried at room temperature for 48 hours and inspected for evidence of air leaks.

Heater–Cycling Life Test– A sample is subjected to 2000 on–off heater cycles at the following conditions. Ef = 7.5V (heaters in parallel); Ehk = +135 Vdc and other elements floating. At the conclusion of this test the tubes will not show open heater or cathode circuits and meet a maximum Ihk leakage limit of 15 μAdc.

Stability Life Test– Sample is operated for two and twenty hours to evaluate initial electrical stability (Δ_t Sm < 10%).

Survival Rate Life Test – Sample is operated one hundred hours to evaluate inoperatives and early electrical stability.

Intermittent Life Test – 1000 hours. Sample is operated with minimum Envelope Temperature of 165 °C.

Interface Life Test– 500 hours. Sample is operated with Ef = 6.9 V (heaters in parallel) other electrodes disconnected. (Interface resistance < 50 ohms).

Altitude – Sample is subjected to a pressure of 55 ± 5 mmHg to evaluate flashover or corona at the pins of the tube.

APPLICATION NOTES

CAUTION – – – To Electron Equipment Design Engineers. Special attention should be given to the temperature which the tubes are to be operated. Reliability will be seriously impaired if maximum bulb temperature is exceeded. The life expectancy may be reduced if conditions other than those specified for life test are imposed on the tube and will be reduced appreciably if maximum ratings are exceeded. Both reliability and performance will be jeopardized if filament voltage ratings are exceeded. Life and reliability of performance are closely related to the degree that regulation of the heater voltage is maintained at its center rated value.

ACCEPTANCE CRITERIA

The following tests shall be performed:

For the purpose of inspection, use applicable reliable paragraphs of Specification MIL–E–1.

For miscellaneous requirements, see 3.6.

Par. No.	Test (See Note 1)	Conditions	AQL (Percent Defective)	Inspection Level or Code	Symbol	LIMITS (See Note 2)						Units
						Min	Lal	Bogie	Ual	Max	Ald	
GENERAL												
3.1	Qualification	Required for JAN marking	---	---	---	---	---	---	---	---	---	---
3.6	Performance		---	---	---	---	---	---	---	---	---	---
QUALIFICATION TESTS (see note 3)												
---	Cathode	Coated unipotential	---	---	---	---	---	---	---	---	---	---
3.4.3	Base Connections	Outline E9–1	---	---	---	---	---	---	---	---	---	---
4.9.20.3	Variable frequency vibration (1)	Ec=–3 Vdc; Rp=2,000; Rk=0 (see note 4)	---	---	Ep	---	---	---	---	100	---	mVac
MEASUREMENT ACCEPTANCE TESTS, PART 1 (see note 5)												
4.10.8	Heater Current		---	---	If	---	146	150	154	---	9	mA
4.10.8	Heater Current		0.4	II	If	142	---	---	---	158	---	mA
4.10.15	Heater–Cathode Leakage	Ehk=+100 Vdc Ehk=–100 Vdc (see note 6)	0.4	II	Ihk Ihk	--- ---	--- ---	--- ---	--- ---	7 7	--- ---	μAdc μAdc
4.10.6.1	Total Grid Current	Rg=0.5 Meg (see note 6)	0.4	II	Ic	0	---	---	---	–0.7	---	μAdc
4.10.4.1	Plate Current (1)	(see note 6)	---	---	Ib	---	8.5	10.0	11.5	---	3.4	mAdc
4.10.4.1	Plate Current (1)	(See note 6)	0.4	II	Ib	7.0	---	---	---	14.0	---	mAdc
4.10.4.1	Plate Current (2)	Ec=–20 Vdc; Rp=0.1 Meg; Rk=0; Ck=0 (see note 6)	0.4	II	Ib	---	---	---	---	100	---	μAdc
4.10.9	Transconductance (1)	Ck=1,000 μf (see note 6)	---	---	Sm	---	5000	5500	6000	---	1000	μmhos
4.10.9	Transconductance (1)	Ck=1000 μf (see note 6)	0.4	II	Sm	4500	---	---	---	6500	---	μmhos
4.7.5	Continuity and Shorts		0.4	II	---	---	---	---	---	---	---	---
4.9.1	Mechanical–production tests	Outline 6–7	---	---	---	---	---	---	---	---	---	---

Par. No.	Test (See Note 1)	Conditions	AQL (Percent Defective)	Inspection Level or Code	Symbol	LIMITS (See Note 2) Min	Lal	Bogie	Ual	Max	Ald	Units
MEASUREMENTS ACCEPTANCE TESTS, PART 2												
4.8	Insulation of electrodes	(see note 6) E (g–all)=–100 Vdc E (p–all)=–300 Vdc	2.5	L6	R R	500 500	--- ---	--- ---	--- ---	--- ---	--- ---	Meg Meg
4.10.4.1	Plate Current (1) (difference between sections)		2.5	I	Ib	---	---	---	---	3.2	---	mAdc
4.10.4.1	Plate Current (3)	Ec=–7.0 Vdc Rp=0.1 Meg Rk/k=0 (see note 6)	2.5	I	Ib	5	---	---	---	---	---	μAdc
4.10.9	Transconductance (2)	Ef=11.4 V Ck=1000 μf (see note 6)	2.5	I	Δ_{Ef}Sm	---	---	---	---	15	---	%
4.10.6.2	Grid Emission	Ef=15.0 V Ec=–20 Vdc; Rg/g=0.5 Meg Rk=0; Ck=0 (see notes 6 and 7)	2.5	I	Ic	0	---	---	---	–1.5	---	μAdc
4.10.3.1	Radio–frequency noise (other than shot–effect noise)	Ecal=15 mVac Rk=100; Ck=0.2 μf (see notes 4 and 8)	2.5	I	---	---	---	---	---	---	---	---
4.10.3.4	Noise and microphonics (for reliable receiving tubes)	Ef=12.6 Vdc; Ebb=300 Vdc; Ecal=100 mVac; Rk=200; Rp=10,000; grid grounded; Ck=1,000 μf (see notes 4 and 9)	2.5	I	---	---	---	---	---	---	---	---
---	Pulse cathode current	Ef=12.6 V Eb=250 Vdc; Ec=–30 Vdc; Rk=1.0 (see notes 6 and 10)	2.5	Code H	ik	280	---	---	---	---	---	ma
4.10.11.1	Amplification factor	(see note 6)	6.5	L6	Mu	50	---	---	---	70	---	---
4.10.14	Direct Interelectrode capacitance	No shield No shield No shield; section 1 No shield; section 2 No shield No shield	6.5	Code E	Cgp Cin Cout Cout Cpp Chk	1.30 2.00 0.20 0.16 0.15 2.10	--- --- --- --- --- ---	--- --- --- --- --- ---	--- --- --- --- --- ---	1.90 3.00 0.70 0.60 0.33 3.50	--- --- --- --- --- ---	μμf μμf μμf μμf μμf μμf
4.9.12.1	Low–pressure voltage breakdown	Pressure=55±5 mmHg; voltage=500 Vac	6.5	(See Note 11	---	---	---	---	---	---	---	---
4.9.19.1	Low–frequency vibration (2)	Ec=–3 Vdc; Rp=2,000; Rk=0; Ck=0; G=10; F=40 cps (see note 4)	6.5	Code I	Ep	---	---	---	---	100	---	mVac
DEGRADATION RATE ACCEPTANCE TESTS, (see note 12)												
4.9.20.5	Shock test	Hammer angle=42°; Ehk=+100 Vdc (see note 13)	---	---	---	---	---	---	---	---	---	---
4.9.20.6	Fatigue test	G=2.5; fixed frequency; F=25 min. 60 max.	6.5	(See Note 11	---	---	---	---	---	---	---	---
---	Post shock and fatigue test end points	Vibration (2)	---	---	Ep	---	---	---	---	150	---	mVac
		Heater-cathode leakage										
		Ehk=+100 Vdc	---	---	Ihk	---	---	---	---	20	---	μAdc
		Ehk=–100 Vdc	---	---	Ihk	---	---	---	---	20	---	μAdc
		Transconductance (1)	---	---	Sm	3800	---	---	---	---	---	μmhos
		Grid Current	---	---	Ic	0	---	---	---	–1.5	---	μAdc

Par. No.	Test (See Note 1)	Conditions	AQL (Percent Defective)	Inspection Level or Code	Symbol	LIMITS (See Note 2) Min	Lal	Bogie	Ual	Max	Ald	Units
4.9.6.1	Miniature–tube base–strain		---	---	---	---	---	---	---	---	---	---
4.9.6.3	Glass strain (for receiving tubes)		2.5	I	---	---	---	---	---	---	---	---
4.11.7	Heater–cycling life test	Ef=7.5 V; heaters in parallel Ehk=+135 Vdc (see note 14)	---	---	---	---	---	---	---	---	---	---
4.11.4	Life–test end points	Heater cathode leakage										
		Ehk=+100 Vdc	---	---	Ihk	---	---	---	---	15	---	μAdc
		Ehk=–100 Vdc	---	---	Ihk	---	---	---	---	15	---	μAdc
---	Stability life test	Ehk=+135 Vdc Rg/g=0.5 meg. TA=room (see note 15)	1.0	Code I	---	---	---	---	---	---	---	---
4.11.4	Life–test end points (stability) (2 and 20 hours)	Change in transconductance (1) of individual tubes	---	---	Δ_tSm	---	---	---	---	10	---	%
4.11.3.1(b)	Survival–rate life test	Stability life test conditions or equivalent (see notes 16 and 17)	---	II	---	---	---	---	---	---	---	---
4.11.4	Life–test end points (survival rate) (100 hours)	Continuity and shorts	0.65	---	---	---	---	---	---	---	---	---
		Transconductance (1)	1.0	---	Sm	3800	---	---	---	---	---	μmhos
4.11.5	Intermittent life–test operation	Stability life test conditions; T (envelope)= 165°C min (see notes 18 and 19)	---	---	---	---	---	---	---	---	---	---

Par. No.	Test	Conditions	AQL (Percent Defective)	Inspection Level or Code	Allowable Defects per characteristic First Sample	Combined Sample	Sym.	LIMITS Min	Max	Units
ACCEPTANCE LIFE TESTS (cont'd.)										
4.11.4	Life–test end points (intermittent) (500 hours)	(See note 20) Inoperatives	---	---	1	3	---	---	---	---
		(See note 21) Total grid current	---	---	1	3	Ic	0	–0.7	μA
		Heater Current	---	---	1	3	If	142	162	mA
		Change in transconductance (1) of individual tubes	---	---	1	3	Δ_tSm	---	20	%
		Transconductance (2)	---	---	1	3	Δ_{Ef}Sm	---	15	%
		Heater–cathode leakage								
		Ehk=+100 Vdc	---	---	1	3	Ihk	---	7	μAdc
		Ehk=–100 Vdc					Ihk	---	7	μAdc
		Insulation of electrodes								
		E(g–all)=–100V	---	---	1	3	R	250	---	Meg.
		E(p–all)=–300 V					R	250	---	Meg.
		Transconductance (1) average change	---	---	---	---	AvgΔ_tSm	---	15	%
		Total defectives	---	---	3	6	---	---	---	---

Par. No.	Test	Conditions	AQL (Percent Defective)	Inspection Level or Code	Allowable Defects per Characteristic: First Sample	Allowable Defects per Characteristic: Combined Sample	Sym.	LIMITS: Min.	LIMITS: Max.	Units
ACCEPTANCE LIFE TESTS (cont'd.)										
4.11.4	Life–test end points (intermittent) (1000 hours)	(See note 20) Inoperatives (see note 21)	---	---	1	3	---	---	---	---
		Total grid current	---	---	1	3	Ic	0	–0.7	μAdc
		Heater current	---	---	1	3	If	142	164	mA
		Change in transconductance (1) of individual tubes	---	---	1	3	$\Delta_t Sm$	---	25	%
		Transconductance (2)	---	---	1	3	$\Delta_{Ef} Sm$	---	20	%
		Heater–cathode leakage								
		Ehk=+100 Vdc	---	---	1	3	Ihk	---	7	μAdc
		Ehk=–100 Vdc					Ihk	---	7	μAdc
		Insulation of electrodes								
		E(g–all)=–100 Vdc	---	---	1	3	R	100	---	Meg
		E(p–all)=–300 Vdc					R	100	---	Meg
		Total defectives	---	---	4	8	---	---	---	---
4.11.8	Cathode interface life test	Ef=6.9 V; heaters in parallel; other electrodes disconnected (see note 22)	---	---	---	---	t	500	---	hr
4.11.4	Life–test end points	Ef=5.7±0.05 Vdc, heaters in parallel, Eb=135 Vdc; Ec/Ib=2.0 mAdc (see notes 23 and 24)	---	---	1	3	Ri	---	50	ohm
4.9.18	Container drop (see note 25)	(d) Package group 1, container size B								

Note 1: The sequence of tests listed hereon is the suggested order in which the tests should be conducted.

Note 2: Variables sampling procedure (see 4.1.1.7).

Note 3: All tests listed hereon shall be performed during qualification; however, these three tests are normally performed qualification inspection only.

Note 4: Tie 1k to 2k; 1g to 2g; and 1p to 2p.

Note 5: The AQL for the combined defectives for attributes in measurements acceptance tests, part 1, excluding inoperatives and mechanical shall be 1 percent.

Note 6: Test each unit separately.

Note 7: Prior to this test, tubes shall be preheated a minimum of 5 minutes with all sections operating at the conditions indicated below. The 3–minute test is not permitted. Test at specified conditions within 3 seconds after preheating. Grid emission shall be the last test performed on the sample selected for the grid emission test.

Ef V	Ec1 Vdc	Eb Vdc	Rk/k ohms	Rg/g Meg
15.0	0	250	200	0.5

Note 8: In addition to the rejection criteria of 4.10.3.1, the output shall be read on a VU meter using a rejection limit of 5 VU. Five VU is the meter deflection obtained with a steady state output of 3 mW from the amplifier.

NOTES (con't)

Note 9: The rejection level shall be set at the VU meter reading obtained during calibration.

Note 10: The grid is driven with a pulse voltage as follows: egk=+30 v; prr=1000; tp=10 μs; tr<1 μs; tf<1 μs (egk shall be defined as the instantaneous peak voltage between the grid and the negative end of the cathode resistor). Peak cathode current shall be measured by means of a high impedance oscilloscope, or equivalent, device connected across a cathode resistor of 1.0 ohm. Pre-heat at Ef=12.6 V for 5 minutes; no other voltages applied.

Note 11: This test shall be conducted on the initial lot and thereafter on a lot approximately every 30 days. When one lot has passed, the 30-day rule shall apply. In the event of lot failure, the lot shall be rejected and the succeeding lots shall be subjected to this test until one lot passes. Standard MIL-STD-105, sample size code letter F, shall apply.

Note 12: Destructive tests. Tubes subjected to the following destructive tests shall not be delivered on the contract or order:

- 4.9.20.5 Shock test
- 4.9.20.6 Fatigue test
- 4.11.7 Heater-cycling life test
- 4.11.5 Intermittent life-test operation
- 4.11.8 Cathode interface life test

Note 13: A grid resistor of 0.1 Meg shall be added to each section; however, this resistor shall not be used when a thyratron-type short indicator is employed.

Note 14: The no-load to steady state full load regulation of the heater voltage supply shall be not more than 3.0 percent. This test shall be made on a lot-by-lot basis. A failure or defect shall consist of an open heater, open cathode circuit, heater-cathode short, or heater-cathode leakage current in excess of the specified heater-cycling life-test end-point limit.

Note 15: Stability life test. See 20.2.5.1 of Appendix C.

Note 16: Survival-rate life test. See 20.2.5.2 to 20.2.5.2.4, inclusive, of Appendix C.

Note 17: For survival-rate life test, the equivalent stability life-test conditions shall be so specified in 20.2.5.2.5 of Appendix C.

Note 18: Intermittent life tests. See 20.2.5.3 of Appendix C.

Note 19: Envelope temperature is defined as the highest temperature indicated when using a thermocouple of No. 40 B & S or smaller diameter elements welded to a ring of 0.025-inch diameter phosphor bronze in contact with the envelope. The envelope temperature requirement will be satisfied if a tube having bogie plate current (±5 percent) under normal test conditions, is determined to operate at or above the minimum specified temperature in any position of the life-test rack.

Note 20: Order for evaluation of life-test defects. See 4.11.3.1.2.

Note 21: An inoperative as referenced in life test is defined as a tube having one or more of the following defects: Discontinuity (see 4.7.1 except tube shall not be tapped), permanent short (see 4.7.2 except tube shall not be tapped), air leaks. (See 4.7.6)

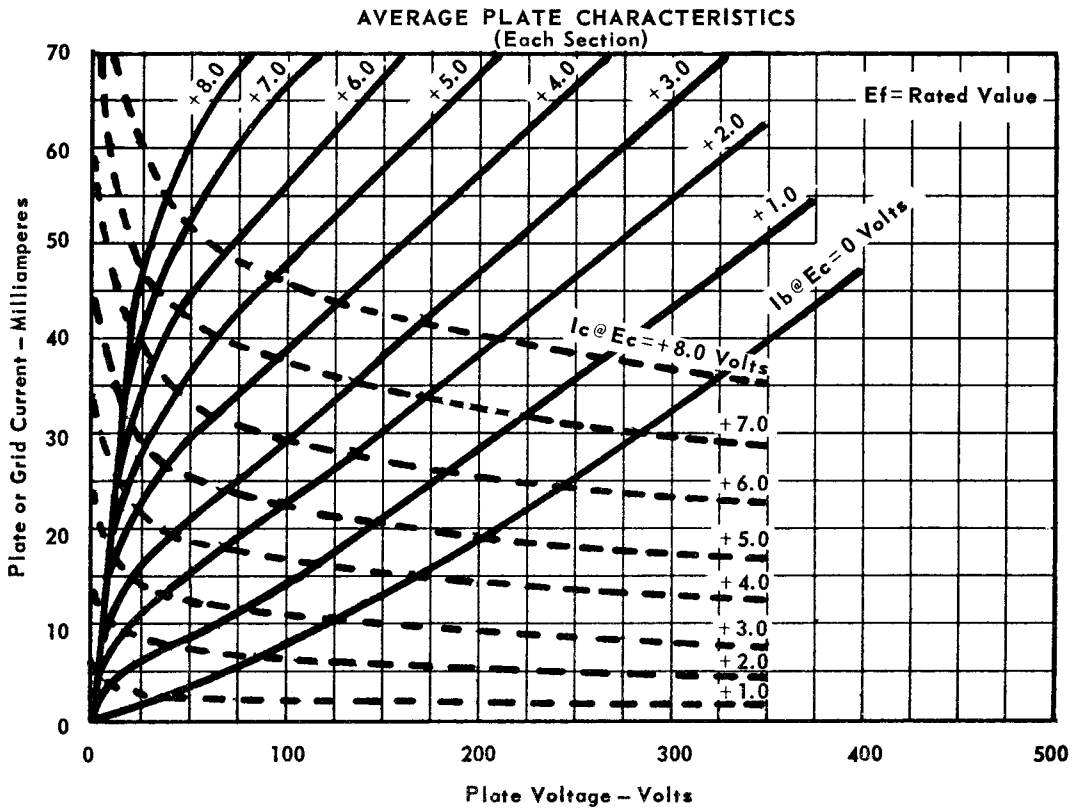
Note 22: The cathode interface life-test sample shall consist of 20 tubes, and not more than one tube failure shall be permitted. In the event of rejection of the first sample due to failure of more than one tube, a second sample of 40 tubes shall be selected from the lot. Acceptance shall then be based on the combined first and second samples. The total tube failures from the combined first and second samples shall not exceed three. A life-test defect is defined as a failure to meet the life-test end-point limits as specified on the tube specification sheet. The cathode interface life-test sample shall be read at zero hours and 500 hours (plus 48 hours, minus 24 hours).

NOTES: (cont'd.)

Note 23: Preheat approximately 5 minutes prior to testing, using either Ef=11.4 V (heaters in series) or Ef=5.7 V (heaters in parallel), other electrodes disconnected. No other test shall be made from the start of the cathode interface life test until after the measurement of the end point characteristic, following completion of the indicated minimum number of life–test hours.

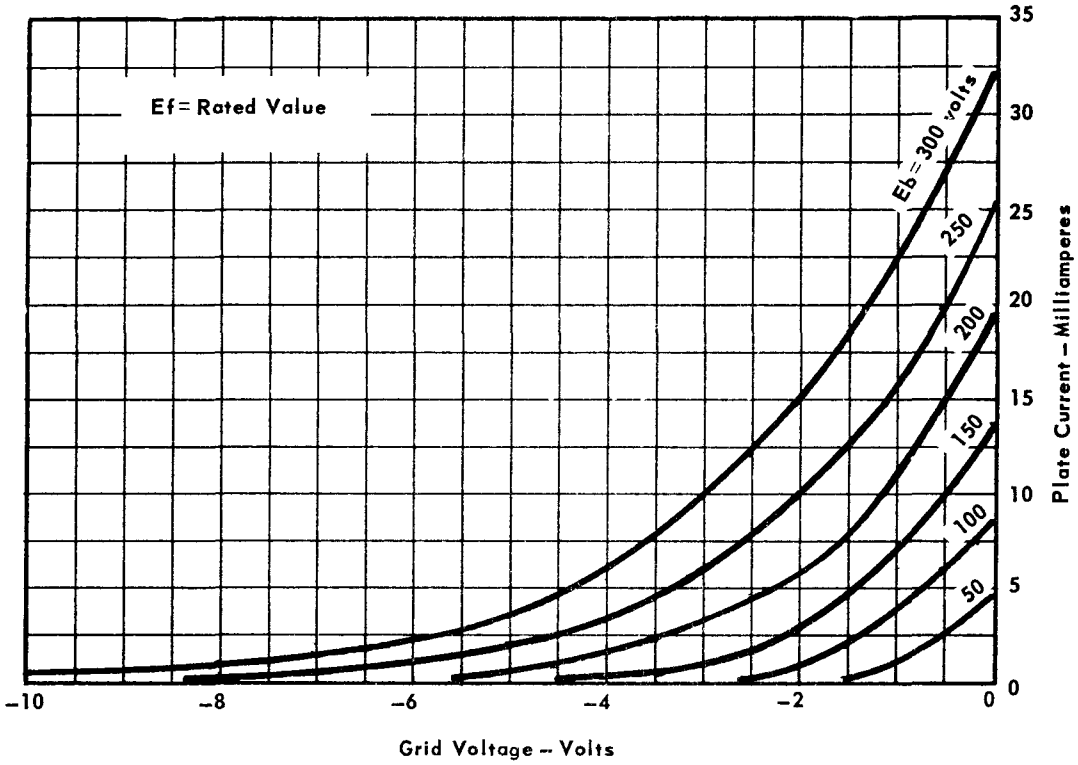
Note 24: The value of interface resistance shall be measured in the standard test circuit. Drawing 248–JAN. As an alternative, a test method known to correlate with the method and conditions specified in this specification sheet may be utilized.

Note 25: Not required for qualification.



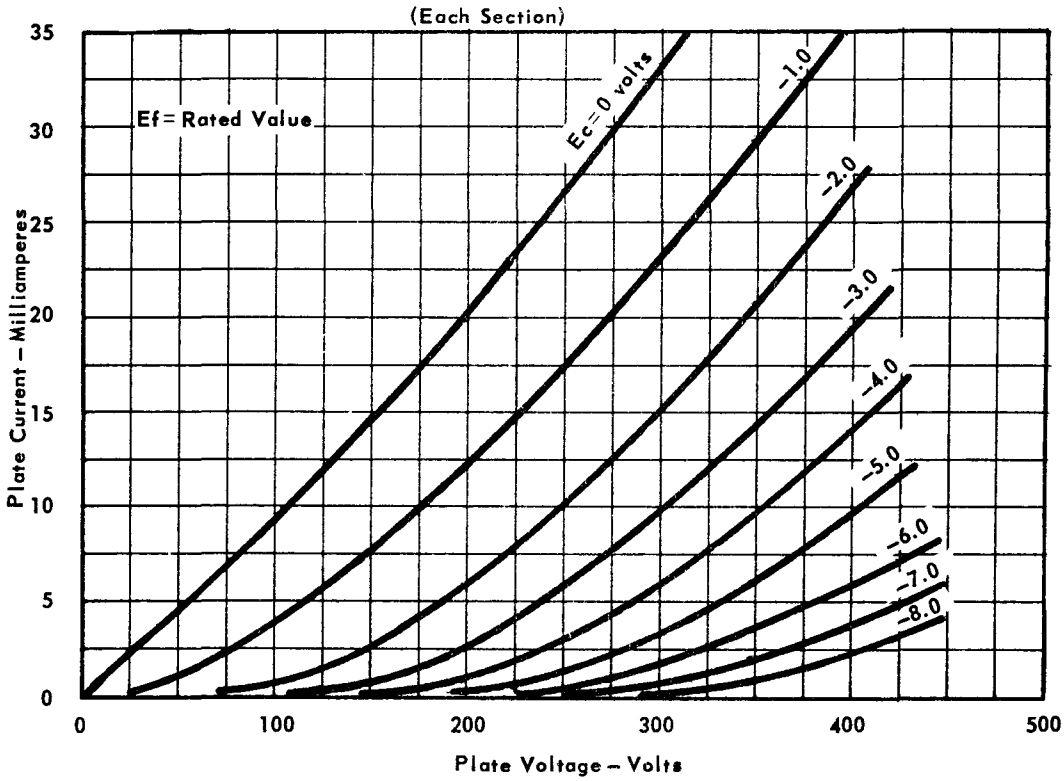
RELIABLE MINIATURE DOUBLE TRIODE

AVERAGE TRANSFER CHARACTERISTICS

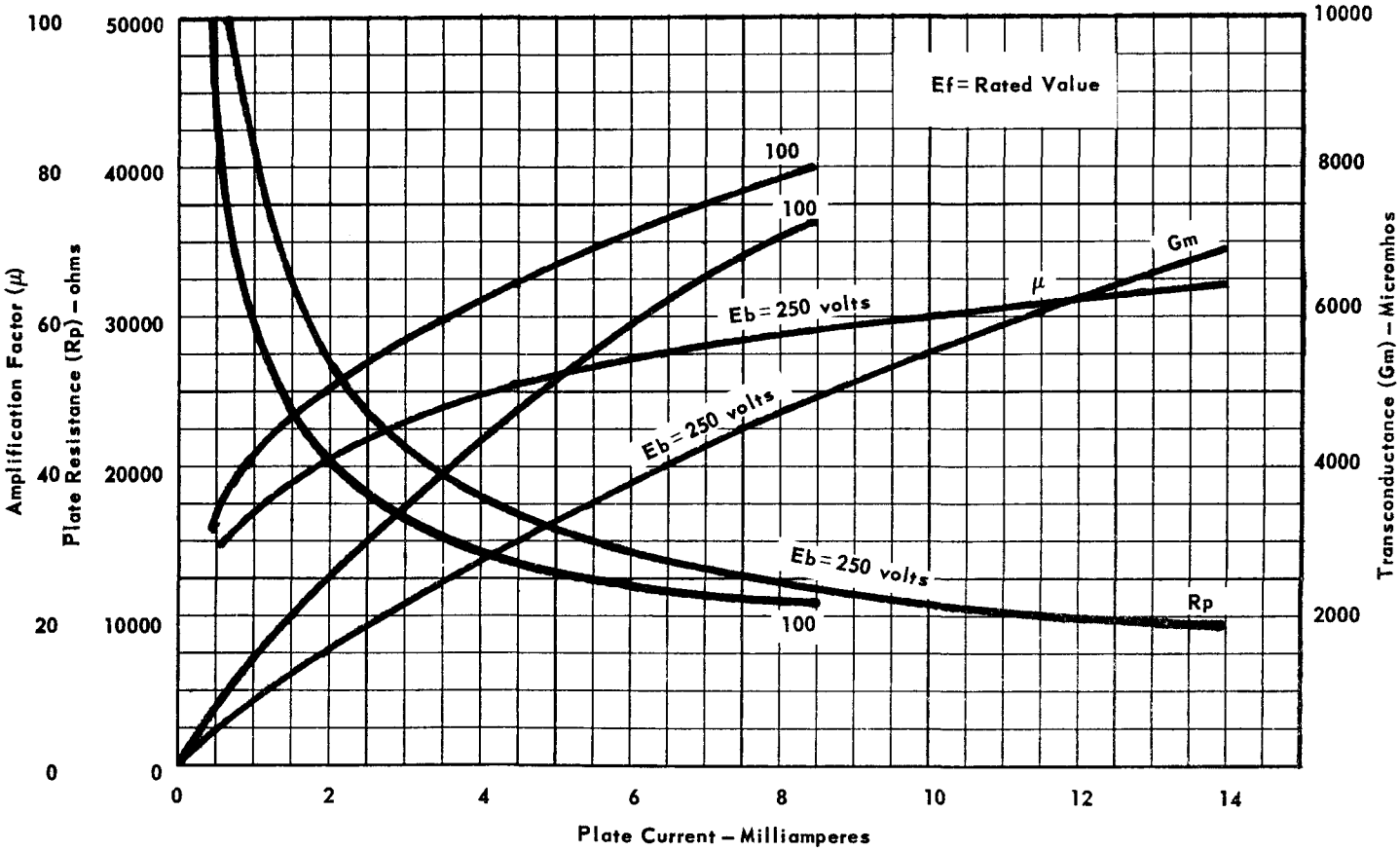


AVERAGE PLATE CHARACTERISTICS

(Each Section)



12AT7WA

RELIABLE MINIATURE DOUBLE TRIODE

AVERAGE CHARACTERISTICS
(Each Section)